How this investigation fits within the “Concept and Lesson Map”:

**Overview for Unit 4: Solids and Liquids with Water**

When solids and liquids are mixed together, sometimes the solid changes, sometimes the liquid changes, sometimes both change, and sometimes neither changes.

Overarching question(s) for this whole investigation:

* What happens to the parts when we mix solids and liquids?

**Attending to “How People Learn”**

How People Learn Key Finding #1: Preconceptions

Eliciting Student Ideas:

* Prior to beginning the Investigation have students complete the Formative Assessment Probe, “Solids and Liquids with Water.” Walk through the probe together, taking time for students to draw in each “cup” what they think they would see. Encourage students to record only their own ideas. When the Investigation is complete, students will complete this probe again and compare their two responses, looking for changes in their thinking and trying to determine what events brought about those changes.

Common Student Preconceptions:

* The exemplary liquid is water so all liquids may be regarded as “watery” or “made of water” or “containing water” (Driver 2002)
* Classifying more viscus liquids (paste, honey, tomato sauce) can be more problematic than “runny” ones (Driver 2002)
* May regard the liquid form of a material as having less weight (or occasionally more weight) than the same mass of its solid form (Driver 2002)
* Up to age 8 there is a tendency to focus on the solute only and say it “just goes”, “disappears”, “melts away”, “dissolves away” or “turns into water” (Driver 2002)
* When the response “melts” is probed, many children tend to describe it as a similar to ice “going runny” (Driver 2002)
* About half of 8 year olds thought that the substance dissolved is preserved in some form, but only about half of those will say the substance dissolved weighs something (Driver 2002)
* Students believe that when a chemical dissolves, it has changed form. (WA Laser 2006)
* They also do not understand that all elements/molecules will go into any of the 3 states of matter depending on temperature. (WA Laser 2006)

How People Learn Key Finding #2: Facts/Concepts/Knowledge

WA State Content Standards “Science Domains” (EALR 4)

* K-1 PS2A Liquids take the shape of the part of the container they occupy.
* K-1 PS2B Solids retain their shape regardless of the container they are in.

WA State Science Standards “Crosscutting Concepts and Abilities” (EALRs 1-3)

* K-1 SYSB Some objects can easily be taken apart and put back together again while other objects cannot be taken apart without damaging them
* K-1 INQA Scientific investigations involve asking and trying to answer a question about the natural world my making and rcording observations
* K-1 INQC Scientists develop explanations, using recorded observations (evidence)
* K-1 INQD Scientists report on their investigations to other scientists, using drawings and words.
* K-1 INQE Observations are more reliable if repeated, especially if repeated by different people.
* K-1 INQF All scientific observations must be reported honestly and accurately.
* K-1 APPC A problem may have more than one acceptable solution
* K-1 APPD Counting, classifying, and measuring can sometimes be helpful in solving a problem.

Key Understandings For the Teacher:

* When solids and liquids, or liquids and liquids, mix, many different things can happen. They can combine or stay separate, they may combine right away or it may take time.
* When solids and liquids mix, sometimes the solid changes, sometimes the liquid changes, sometimes both change, and sometimes neither changes. Often mixtures can be put together and taken apart in a reversible interaction (laying the foundation for the idea that nothing is ever “lost.”)
* Students need to make their own determinations based on their own actions and observations, and communicate and defend the reasoning behind their conclusions. (scientific thinking is more important than an accurate outcome at this level.)

How People Learn Key Finding #3: Metacognition

Metacognition: How did my thinking change? What caused the change? How did I come to believe this?

Each of the following assessments offers the opportunity to help students look at how their thinking has changed after having new experiences. The focus needs to be on helping students make the connection that their thinking **has** changed, not just that they completed the task set forth by the teacher.

**Suggested Assessments for Student Understanding:**

* Part 1: If students make predictions prior to each of the breakpoints, their reasoning can be probed and revisited after results are recorded, looking for differences and what caused the changes in thinking.
* Part 3: Prior to the breakpoints in part 3, have students record predictions in their science notebooks, look to see if they have applied new understandings/learning from parts 1 and 2. Focus on what experiences they had that helped them make their predictions. (how their thinking has changed)
* Part 3: (“Toothpaste Investigation”) is a wonderful opportunity to see students using what they have learned to classify an “unknown” substance. It is more important for students to make determinations based on their evidence and communicate and defend those beliefs, than it is for the class to come to a consensus about whether the toothpaste is a solid or a liquid. This can be used as an end of the unit performance based assessment. Like Oobleck, toothpaste is a mixture of both solid and liquid. This was chosen to provide an opportunity for students scientists to grapple with and discuss whether they believe it is a solid, liquid, or both based on their observable evidence. Scientific argumentation of student ideas should be embraced and encouraged. As students are observing and interacting with the toothpaste mixture, pay attention to how students are describing the properties. Do they use they use or refer to prior investigation experiences to support their idea of a solid or liquid?
* After completing the Investigation, have students complete the Assessment Probe, “Solids and Liquids with water” again, then let them compare their pre-assessment to see how their thinking has changed. Encourage them to think about which activities led to the changes in thinking

**Additional Information**

Materials and Student Management

* Part 1: some of the solids suggested will behave differently if the container they are in is stirred or shaken. Decide before beginning whether or not you want the students to agitate the mixture.
* Part 1: Consider whether you would like to use plastic baggies as suggested, or whether a clear plastic cup would be more appropriate for your students.
* Part 1: Prior to each of the breakpoints in part 1 have students make a prediction about what they expect to see when they return. These predictions could be recorded in pictures and/or words in a science notebook, allowing an opportunity for reflection.
* Part 2: During the wrap-up for part 2, consider asking students if the liquids could be separated the way the solids/liquids were.
* Part 2: After part 2, read *Mix it Up!* from FOSS Science Stories
* Part 3: If students have shown an interest in another substance besides toothpaste, consider using it instead
* Part 3: Prior to each of the breakpoints have students make predictions that can be recorded in their science notebooks.
* Interdisciplinary extensions: There are many interesting science interdisciplinary extensions for this investigation, if you have time and if students show interest, they could be done whole class, small group, or as stations.